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To: [REDACTED] (USAID-OIEE)

From: [REDACTED] (Tetra Tech AESP)

Date: July 14, 2011

Re: Leach Field Data Collection and Analysis Results, Revision 1

This technical memorandum summarizes Tetra Tech's leach field data collection and analysis effort at Sardar Girls High School (SGHS) in Kabul, Afghanistan, under WO-LT-0006 Amendment #6 of the Afghanistan Engineering Services Program (AESP) for the USAID Office of Infrastructure, Energy, and Engineering (OIEE).

After assessing the design and maintenance requirements associated with the installation of the package WWTP at SGHS, USAID has requested that Tetra Tech assess the feasibility of using an on-site leach field wastewater treatment system instead of the package WWTP. The purpose of this data collection and analysis effort is to gain a better understanding of the site characteristics and wastewater quantities in order to determine the feasibility of installing an on-site septic tank and leach field system.

The results of this data collection and analysis effort show that the SGHS wastewater flow demand could be sustainably managed by a leach field system based on percolation rates determined on-site. Based on these results, Tetra Tech recommends that USAID move forward with the leach field conceptual design.

Percolation Testing

From July 10 to 12, 2011, Tetra Tech subcontractor, Pamir Geotechnical Services Company (Pamir) performed percolation testing at the site. Percolation testing was executed at six locations located uniformly within the proposed leach field area. Percolation testing was performed per the *United States Army Corps of Engineers (USACE) Afghanistan Engineering Design Requirements: Sanitary Sewer and Septic System*, dated June 2010. Photo documentation and location map of the percolation testing is provided in Attachment 1 of this document.

Percolation test pits were hand dug to a depth of 1.0 meter below grade with dimensions of approximately 1.0 meter x 1.0 meter in order to allow visual observation of water depth in the test pit. Each test pit was filled with water 24 hours prior to percolation testing to saturate the underlying soils. Percolation testing began on the morning of July

12. The detailed percolation test report is provided in Attachment 2. Table 1 shows the summary of results from each of the six test pits and the average infiltration rate for the leach field area.

Table 1
Percolation Test Results

Test Pit #	Saturated Percolation Rate (min/25mm)
1	34.09
2	21.43
3	18.75
4	30.00
5	22.06
6	25.00
Average	25.22

The results of the percolation testing show that the soils have slightly higher than average infiltration rates. According to the *AED Design Requirements*, the limits of percolation rates for a leach field system are 0.1 min/25 mm (too fast) and 60 min/25mm (too slow). Each test pit percolation rate and the average percolation rate for the area tested at SGHS have soils with percolation rates that are within the percolation rate limits for leach field soils.

Sanitary Flows

Tetra Tech collected wastewater information to develop a better estimate of the average daily demand and peak flow demand for sanitary flows at SGHS. Flow estimates were developed according to the design guidance in *USACE AED Design Requirements: Sanitary Sewer and Septic Systems*.

During discussions with UNOPS and USAID, Tetra Tech was informed of the maximum capacity of students for each room constructed at SGHS. Table 2 provides an inventory of the design occupancy at SGHS and assumes three shifts of students and staff per day. The total daily design occupancy of SGHS is estimated to be 5,619 persons and the wastewater system will be designed to manage this occupancy.

Table 2
SGHS Occupancy Inventory

Room Description	Quantity (#)	Maximum Occupancy (# persons)	Total Occupancy (# persons)
Classroom	38	38 ^a	1444
Kindergarten	2	38 ^a	76
Laboratory	9	20	180
Computer Room	4	20	80
Teaching Staff	1	53 ^b	53
Cleaning Staff	1	20	20
Administrative Staff	1	20	20
Total			1,873
Number of Shifts			3
Total Daily Occupancy			5,619

^a Furniture contractor installed 19 desks per classroom and each desk seats 2 students

^b Assumes one teacher per classroom, computer room, laboratory, and kindergarten room

Average Daily Flow (ADF)

Discussion between USAID, UNOPS and Tetra Tech from April 2011, determined that an average daily water demand (ADD) per capita of 10 liters/person/day had been applied to USACE school projects in the past and was appropriate for estimating wastewater flows at SGHS.

The average daily flow (ADF) represents the total waste volume generated over a 24-hour period, and is defined as 80% of the product of the total population of the facility (P), the per capita water usage rate per day (ADD), and the applicable capacity factor (CF) which is 1.47 for the SGHS population of 5,619 occupants (CF obtained from the *Basic Design Considerations, UFC 3-240-09FA Domestic Wastewater Treatment, Table 4-1*). The ADF is calculated using the following equation:

$$ADF = 0.80 * P * ADD * CF$$

The resulting ADF is 17,447 gallons/day. This average daily flow is the wastewater flow rate that the leach field will be designed to manage.

Peak Diurnal Flow (PDF)

The peak diurnal flow (PDF) represents the maximum potential flow in the sanitary sewer system is required to adequately size sanitary sewer piping and appurtenances. The peak diurnal flow rate is computed by the following equation:

$$PDF = \frac{Q * C}{2 * Q^{0.167}}$$

Q is the ADF in gallons/day and C is a constant, 38.2. The resulting PDF is 65,221 gallons/day or 45 gallons/minute. This value can be appropriately managed by properly sized sewers and is within the normal range of sanitary peak flow rates for a leach field system.

Conclusions and Recommendations

The results of the percolation testing show that the soils at SGHS in the area of the proposed leach fields have an average percolation rate of 25.22 minutes per 25 millimeter and the site soils are suitable for the implementation of a leach field. The results of the ADF and PDF analysis shows that the sanitary flows at SGHS are within a manageable range for a septic tank and leach field system given the available area on site and soil infiltration rates.

Based on the data gathered during this exercise, Tetra Tech recommends that USAID move forward to the conceptual design phase of the septic tank and leach field system at SGHS. Based on preliminary calculations performed by Tetra Tech, assuming a water demand of 10 liters/day/capita, the leach field will require an area of 30 meters by 66 meters, or 1,980 square meters, which will fit within the available area at SGHS of approximately 2,450 square meters. Performing the calculation for maximizing the available area on-site (2,450 square meters), the maximum water demand is 12.3 liters/day/capita. The leach field conceptual design will determine the optimal location and sizing of the gravity-fed sewers, septic tank and distribution lines.

Attachment 1

Percolation Test Pit Location Map and Photos



Fully excavated and prepared Test Pit #4 prior to saturation



Test Pit Preparation with Gravel and Rebar



Test Pit Saturation One Day Prior to Percolation Testing



Percolation Rate Monitoring on July 12

Attachment 2
Percolation Test Report

Attachment 1

Percolation Test Pit Location Map and Photos



Fully excavated and prepared Test Pit #4 prior to saturation



Test Pit Preparation with Gravel and Rebar




Test Pit Saturation One Day Prior to Percolation Testing



Percolation Rate Monitoring on July 12

This project was made possible by the United States Agency for International Development and the generous support of the American People through USAID Global Architecture and Engineering IQC Contracts.

[illegible]

 USAID FROM THE AMERICAN PEOPLE	DESIGNED BY: JLH	DATE: 12-07-11
	DRAWN BY: ARC	SUBMITTED BY: TETRA TECH
A E S P	CHECKED BY: KWC	CAD FILE NAME: 01

USAID - OIEE
SARDAR GIRLS HIGH SCHOOL
KABUL, AFGHANISTAN
PERCOLATION TEST PIT LOCATION

SHEET
REFERENCE
NUMBER:

01

Attachment 2
Percolation Test Report

Percolation Test Results
OF
SARDAR GIRLS HIGH SCHOOL
Kabul Province, Afghanistan

DATE: July, 2011

Submitted By:



Prepared By:

Pamir Geotechnical Services Company



Percolation Test Results
OF
SARDAR GIRLS HIGH SCHOOL
Kabul Province, Afghanistan

Prepared By:



B.sc. Soil Science

July, 2011

Percolation test

1.1-Result of Percolation Test in Project Area:

In this project area according to AED Design Requirements Sanitary Sewer & Septic System, we performed percolation test with digging a 6 hole and preparing them according AED Design Requirements, then we filled them with clear water and kept water in holes for seven hours, then after 24 hours we started rate measurement of infiltration by method B from AED Design Requirements Sanitary Sewer & Septic System, that in below it is described:

Method (b): If no water remains in the hole the next day, add clean water to bring the depth to approximately 150 mm over the gravel. From the batter board, measure the drop in water level at 30-minute intervals for 4 hours, refilling to 150 mm over the gravel as necessary. The drop in water level that occurs during the final 30-minute period is used to calculate the percolation rate.

Percolation test results for Project area shows average of percolation rate number is equal **25.22minutes/25mm**. It means will take **25.22** minutes for water to drop 25 mm .Percolation Test Points have shown in Figure No 1. And Percolation Test Results have shown in section1.2, and site investigation photos have shown in section1.3.

According to AED Reference table, [AED DESINGN REQUIREMENT FOR SANITARY & SEPTIC SYSTEM, SEPTEMBER 2010 PUBLISHING], and by **considering Percolation Result we recommend using the Leaching field system (Table no.1.).**

Table no.1.AED Reference Table. Soil Treatment Areas in Square Meters
[AED Design Requirements Reference, 2009]

Percolation Rate, Minutes for Water to Drop 25 mm	Water Absorption of Soil (m ² /liters/day)
Faster than 0.1	Soil too coarse for sewage treatment
0.1 to 5	0.020
6 to 15	0.031
16 to 30	0.041
31 to 45	0.049
46 to 60	0.054
Slower than 60	Soil too fine for sewage treatment

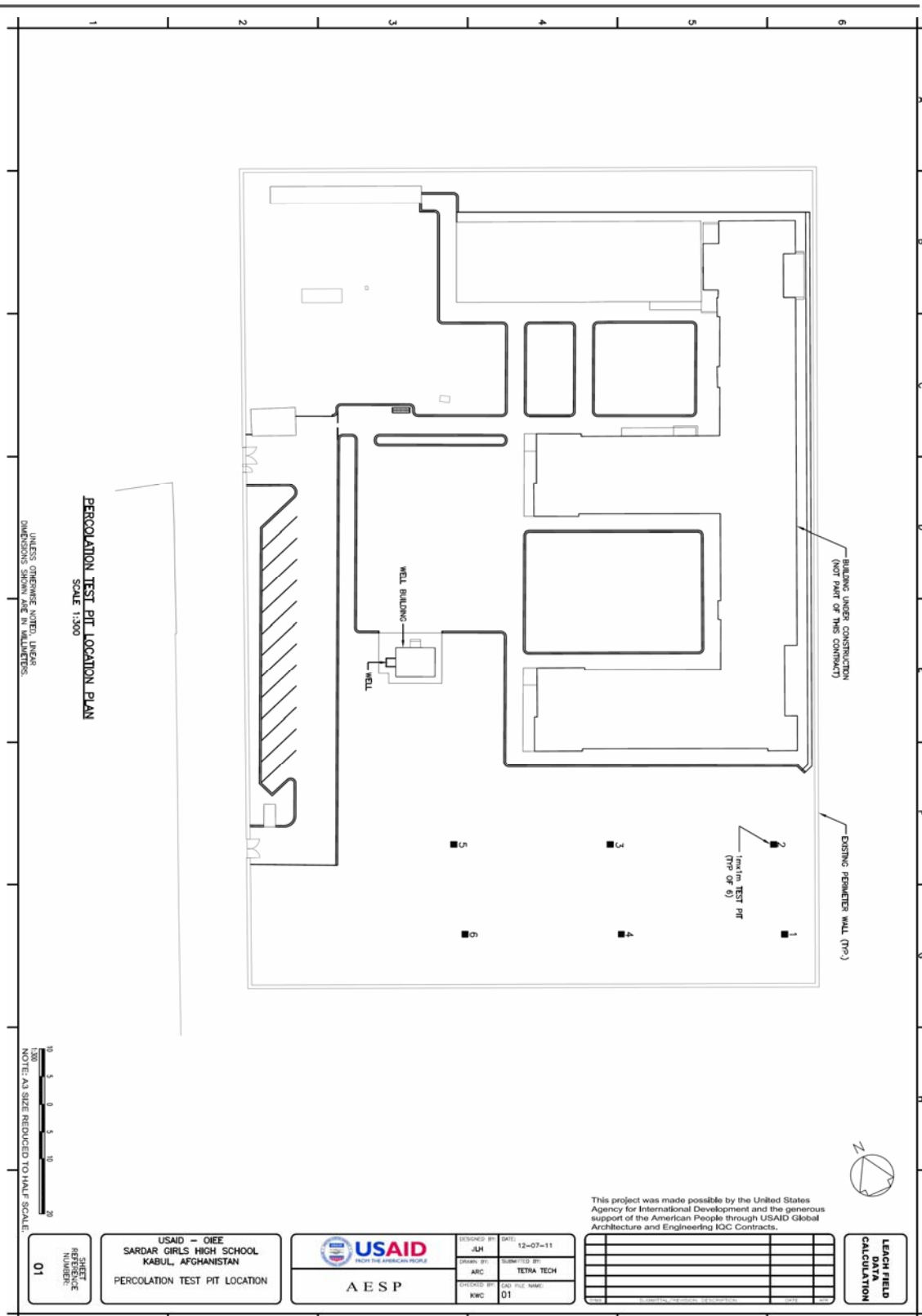


Figure No 1- Location of percolation test pits

1.2- Percolation Test Results

PAMIR GEOTECHNICAL SERVICES COMPANY			
Percolation Test Result			
Company	TETRA TECH		
Project	SARDAR GIRLS HIGH SCHOOL		
Test Location	Leach field	Testing Date	12.07.2011
Test Number	1	Tested by	Eng, M.Ali
Time of Saturation	7 hours	Location	Kabul, Afghanistan
Depth from Natural Surface		1m	
Time of measurement after first filling		24 hours	
Method of Rate Measurement		B	
Time of Reading	Period Time of Reading(min)	Falling of Water Table (mm)	Infiltration (mm)
9:14 AM	0	800	0
9:44	30	825	25
10:14	30	824	24
10:44	30	824	24
11:14	30	823	23
11:44	30	822	22
12:14	30	822	22
12:44	30	822	22
13:14	30	822	22
Results: Minutes/25 mm = Time/(drop/25 mm) = 30 minutes/(22 mm/25 mm) = 34.09 Minutes/25 mm where, Minutes/25 mm = Minutes for water to drop 25 mm.			

PAMIR GEOTECHNICAL SERVICES COMPANY			
Percolation Test Result			
Company	TETRA TECH		
Project	SARDAR GIRLS HIGH SCHOOL		
Test Location	Leach field	Testing Date	12.07.2011
Test Number	2	Tested by	Eng, M.Ali
Time of Saturation	7 hours	Location	Kabul,Afghanistan
Depth from Natural Surface		1m	
Time of measurement after first filling		24 hours	
Method of Rate Measurement		B	
Time of Reading	Period Time of Reading(min)	Falling of Water Table (mm)	Infiltration (mm)
9:05 AM	0	800	0
9:35	30	839	39
10:05	30	835	35
10:35	30	835	35
11:05	30	835	35
11:35	30	835	35
12:05	30	835	35
12:35	30	835	35
13:05	30	835	35
Results: $\text{Minutes}/25 \text{ mm} = \text{Time}/(\text{drop}/25 \text{ mm}) = 30 \text{ minutes}/(35 \text{ mm}/25 \text{ mm}) = 21.43 \text{ Minutes}/25 \text{ mm}$ where, Minutes/25 mm = Minutes for water to drop 25 mm.			

PAMIR GEOTECHNICAL SERVICES COMPANY			
Percolation Test Result			
Company	TETRA TECH		
Project	SARDAR GIRLS HIGH SCHOOL		
Test Location	Leach field	Tesing Date	12.07.2011
Test Number	3	Tested by	Eng, M.Ali
Time of Saturation	7 hours	Location	Kabul,Afghanistan
Depth from Natural Surface		1m	
Time of measurement after first filling		24 hours	
Method of Rate Measurement		B	
Time of Reading	Period Time of Reading(min)	Falling of Water Table (mm)	Infiltration (mm)
9:22 AM	0	800	0
9:52	30	862	62
10:22	30	852	52
10:52	30	845	45
11:22	30	844	44
11:52	30	842	42
12:22	30	840	40
12:52	30	840	40
13:22	30	840	40
Results: $\text{Minutes}/25 \text{ mm} = \text{Time}/(\text{drop}/25 \text{ mm}) = 30 \text{ minutes}/(40 \text{ mm}/25 \text{ mm}) = 18.75 \text{ Minutes}/25 \text{ mm}$ where, Minutes/25 mm = Minutes for water to drop 25 mm.			

PAMIR GEOTECHNICAL SERVICES COMPANY			
Percolation Test Result			
Company	TETRA TECH		
Project	SARDAR GIRLS HIGH SCHOOL		
Test Location	Leach field	Testing Date	12.07.2011
Test Number	4	Tested by	Eng, M.Ali
Time of Saturation	7 hours	Location	Kabul, Afghanistan
Depth from Natural Surface		1m	
Time of measurement after first filling		24 hours	
Method of Rate Measurement		B	
Time of Reading	Period Time of Reading(min)	Falling of Water Table (mm)	Infiltration (mm)
9:30 AM	0	800	0
10:00	30	844	44
10:30	30	838	38
11:00	30	836	36
11:30	30	835	35
12:00	30	831	31
12:30	30	828	28
13:00	30	825	25
13:30	30	825	25
Results: $\text{Minutes}/25 \text{ mm} = \text{Time}/(\text{drop}/25 \text{ mm}) = 30 \text{ minutes}/(25 \text{ mm}/25 \text{ mm}) = 30 \text{ Minutes}/25 \text{ mm}$ where, Minutes/25 mm = Minutes for water to drop 25 mm.			

PAMIR GEOTECHNICAL SERVICES COMPANY			
Percolation Test Result			
Company	TETRA TECH		
Project	SARDAR GIRLS HIGH SCHOOL		
Test Location	Leach field	Testing Date	12.07.2011
Test Number	5	Tested by	Eng, M.Ali
Time of Saturation	7 hours	Location	Kabul,Afghanistan
Depth from Natural Surface		1.1m	
Time of measurement after first filling		24 hours	
Method of Rate Measurement		B	
Time of Reading	Period Time of Reading(min)	Falling of Water Table (mm)	Infiltration (mm)
8:25 AM	0	1100	0
8:55	30	1150	50
9:25	30	1145	45
9:55	30	1143	43
10:25	30	1143	43
10:55	30	1141	41
11:25	30	1138	38
11:55	30	1135	35
12:25	30	1134	34
Results: $\text{Minutes}/25 \text{ mm} = \text{Time}/(\text{drop}/25 \text{ mm}) = 30 \text{ minutes}/(34 \text{ mm}/25 \text{ mm}) = 22.06 \text{ Minutes}/25 \text{ mm}$ where, Minutes/25 mm = Minutes for water to drop 25 mm.			

PAMIR GEOTECHNICAL SERVICES COMPANY			
Percolation Test Result			
Company	TETRA TECH		
Project	SARDAR GIRLS HIGH SCHOOL		
Test Location	Leach field	Testing Date	12.07.2011
Test Number	6	Tested by	Eng, M.Ali
Time of Saturation	7 hours	Location	Kabul, Afghanistan
Depth from Natural Surface		1.2m	
Time of measurement after first filling		24 hours	
Method of Rate Measurement		B	
Time of Reading	Period Time of Reading(min)	Falling of Water Table (mm)	Infiltration (mm)
8:43 AM	0	1200	0
9:13	30	1244	44
9:43	30	1238	38
10:13	30	1236	36
10:43	30	1235	35
11:13	30	1232	32
11:43	30	1230	30
12:13	30	1230	30
12:43	30	1230	30
Results: $\text{Minutes}/25 \text{ mm} = \text{Time}/(\text{drop}/25 \text{ mm}) = 30 \text{ minutes}/(30 \text{ mm}/25 \text{ mm}) = 25 \text{ Minutes}/25 \text{ mm}$ where, Minutes/25 mm = Minutes for water to drop 25 mm.			

1.3- Site Investigation Photos



a- Test Pit No 2



b- Test Pit No 3



c- Test Pit No 3, existing sand and gravel in depth 1m



d- Preparing hole before saturation



e- Saturation holes for 7 hours



f- no water remains in the hole for next day



g- Measuring the drop in water level from the batter board



h- Backfilling holes and cleaning site